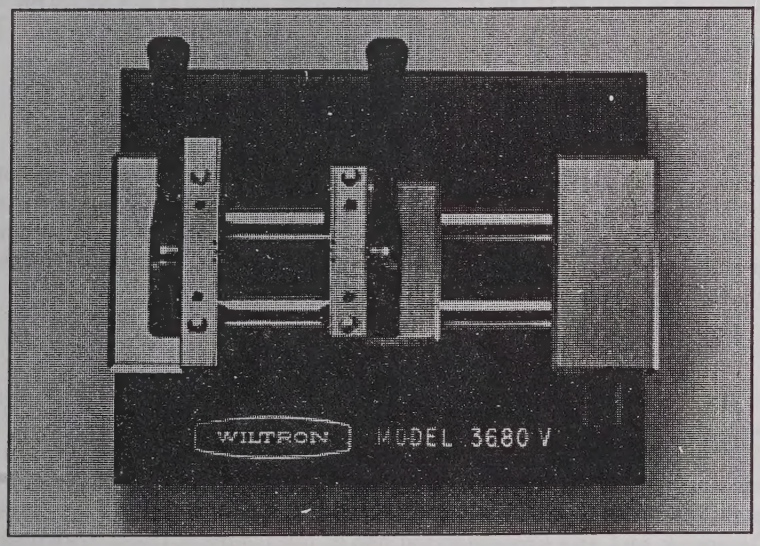
Anritsu

3680 Series
Universal Test Fixture*

Operation and Maintenance Manual



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*U.S. Patent No. 5,017,865

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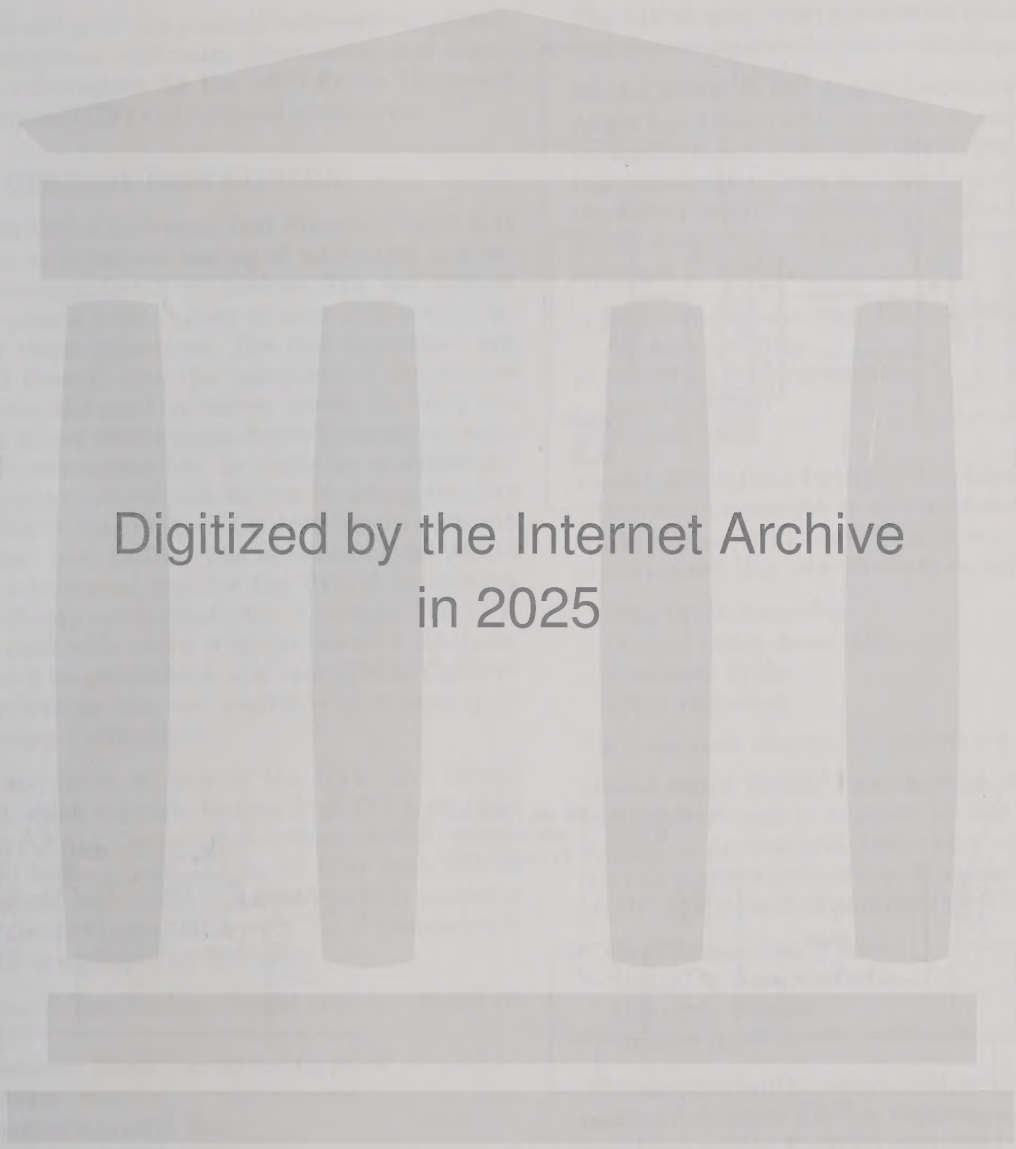

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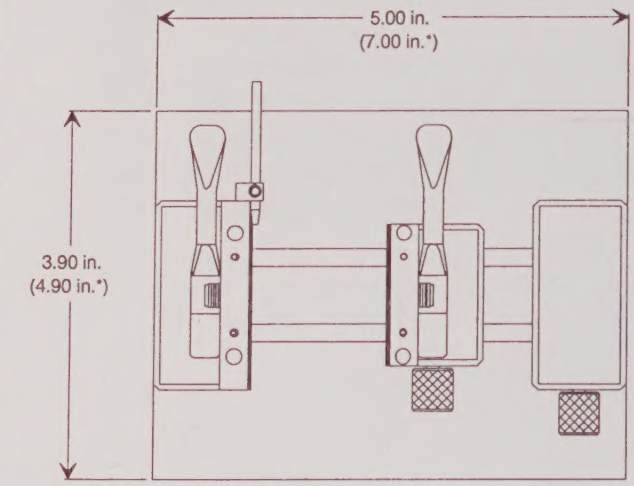
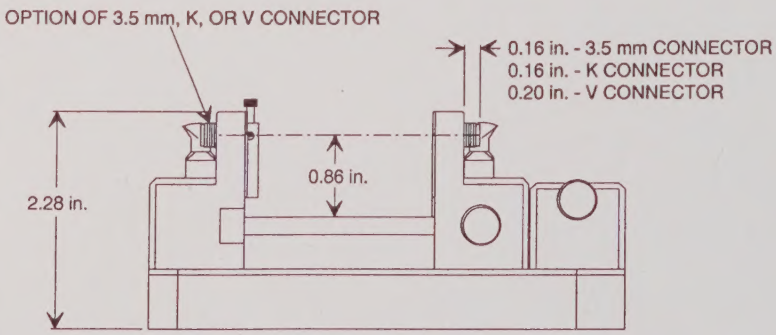


* MODEL 3680-20



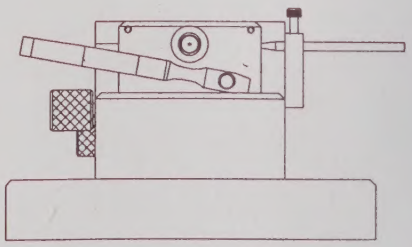


Figure 1-1. 3680 Series Universal Test Fixture

SECTION I
GENERAL INFORMATION

1-1 INTRODUCTION

This manual provides general information, operating instructions, calibration procedures, and maintenance information for the 3680 Series Universal Test Fixture (UTF) and optional accessories.

1-2 GENERAL DESCRIPTION

The 3680 Series Universal Test Fixture (Figure 1-1) supports on-substrate testing of microstrip and coplanar waveguide (CPW) devices. The test fixture accomodates a wide variety of sizes and configurations of these substrates. The test substrates are clamped directly into the launchers of the fixture eliminating the need for carrier blocks. By using the optional Model 36801 Right-Angle Launchers, up to four RF connections can be made on a substrate. Biasing connections can be made using the the Model 36803 Bias Probes. The test fixture supports up to four bias probes. The optional Model 36802 MMIC Attachment enables the fixture to support testing of very small substrates or devices. The UTF can be used with either a scalar network analyzer (SNA) or a vector network analyzer (VNA). Calibration/Verification kits are available in a variety of formats (see Calibration).

There are three models of the UTF; the Model 3680-20 which supports testing from DC to 20 GHz with the 3.5 mm Connector, the Model 3680K, which supports testing from DC to 40 GHz with the K Connector ®, and the Model 3680V, which supports testing from DC to 60 GHz with the V Connector ®. The UTF is equipped as follows:

Universal Test Fixture (Model 3680-20, 3680K or 3680V)
Adjustment Block (for adjusting jaws)
Substrate Stop *
Connector Removal Tool
Screwdriver, Phillips *
Wrenches, 5/16", 2 each *
Wooden Box (Plastic Box for Model 3680-20)

* Not included with Model 3680-20.

K Connector ® and V Connector ® are registered trademarks of the Anritsu Company.

1-3 OPTIONAL ACCESSORIES

The following optional accessories are available. Section 5 provides details concerning their use.

Model 36801 Right-Angle Launcher. The Right-Angle Launcher (RAL) is used to make multi-port connections as well as right angle connections to the test substrates. There are two models of the RAL; the Model 36801V which has a V Connector, and the Model 36801K which has a K Connector. The RAL is equipped as follows:

Right-Angle Launcher (Model 36801K or 36801V)
Adjustment Plate
Mounting Base Assembly
Hex Wrenches
Wooden Box

Model 36803 Bias Probe. ① The Bias Probe is used either as a bias probe or as a hold-down for components. When used as a hold-down, the dielectric probe is used. The Bias Probe is equipped as follows:

Bias Probe Assembly
Ground Cable Assembly
Dielectric Probe
Allen Wrenches

① A 10 bias probe attachment is available as a special item.

Model 36802 MMIC Attachment. The MMIC Attachment is used to support testing of small substrates or devices and substrates where it is not feasible to make connections with the UTF jaws. The MMIC Attachment is equipped as follows:

Cam Assemblies, 2 each
Mounting Base Assembly
Mounting Screws
Wooden Box

A Model 36805-10M, 36805-15M, or 36805-25M Connection Substrate Kit ② is required and must be ordered separately. Each kit contains:

Connection Substrate, 4 each
Mounting Block, 1 each
Pin Foot (Spare), 1 each
Short, 2 each

② Connection Substrate Kit Model 36805-10M is for 10 mil substrates, 36805-15M is for 15 mil substrates, and 36805-25M is for 25 mil substrates.

1-4 SPECIFICATIONS

The mechanical and electrical specifications for the 3680 Series Universal Test Fixture and optional accessories are listed in Table 1-1.

Table 1-1. Specifications for the Series 3680 Universal Test Fixture and Accessories (1 of 3)

MECHANICAL SPECIFICATIONS

SERIES 3680 UNIVERSAL TEST FIXTURE

Overall Size:
4W x 5L x 2H in.

Substrate Types Supported:
Microstrip or Coplanar Waveguide

Substrate Length:
0.2 in. (0.5 cm) minimum
2.0 in. (5 cm) maximum (Models 3680K & 3680V)
4.0 in. (10 cm) maximum (Model 3680-20)

Substrate Width:
No limit on maximum width
0.05 in. (1.2 mm) minimum (see Section 2, para 2-5)

Substrate Thickness:
0.005 in. (0.12 mm) minimum
0.075 in. (1.9 mm) maximum

Line Offset:
±0.5 in. (1.2 cm) maximum (Models 3680K & 3680V)
±1.0 in (2.5 cm) maximum (Model 3680-20)

Input and Output Connectors:
3680-20: 3.5 mm Connector Female
3680K: K Connector Female
3680V: V Connector Female

36801K AND 36801V RIGHT ANGLE LAUNCHER

Distance from In-Line Connector, Axial:
0.4 in. (1 cm) minimum
1.7 in. (4.3 cm) maximum

Distance from In-Line Connector, Offset:
0.0 in. minimum
1.0 in. (2.54 cm) maximum

36802 MMIC ATTACHMENT

Substrate Thickness:
Choice of 0.010 in., 0.015 in., or 0.025 in. substrates

Test Substrate Length:
0.05 in. (0.12 cm) minimum
0.46 in. (1.17 cm) maximum

Maximum Line Offset:
±0.5 in. (1.2 cm)

ELECTRICAL SPECIFICATIONS

Model	Universal Test Fixture			Right Angle Launcher		MMIC Attachment
	3680-20	3680K	3680V	36801K	36801V	36802
Frequency Range (GHz)	DC to 20	DC to 40	DC to 60	DC to 40	DC to 60	DC to 60
Return Loss (Coax Calibration)						
DC to 20 GHz	>17 dB	>17 dB	>17 dB	>16 dB	>16 dB	>12 dB
20 to 40 GHz		>14 dB	>14 dB	>12 dB	>12 dB	>8 dB
40 to 60 GHz			>8 dB		>7 dB	>6 dB
Repeatability of Insertion Loss						
DC to 20 GHz	< ± 0.1 dB	< ± 0.1 dB	< ± 0.1 dB	< ± 0.15 dB	< ± 0.15 dB	< ± 0.2 dB
20 to 40 GHz		< ± 0.2 dB	< ± 0.2 dB	< ± 0.25 dB	< ± 0.25 dB	< ± 0.4 dB
40 to 60 GHz			< ± 0.3 dB		< ± 0.4 dB	< ± 0.6 dB

When used with a Anritsu 360B Vector Network Analyzer

Test Port Characteristics
Test port characteristics apply after optimum calibration, using an Anritsu 36804B Calibration Kit*

Frequency	Directivity	Source Match	Load Match	Noise Floor Relative to a Through Line (Typical)
0.01 GHz	>38 dB	>34 dB	>38 dB	>84 dB
1.0 GHz	>38 dB	>34 dB	>38 dB	>100 dB
20.0 GHz	>38 dB	>34 dB	>38 dB	>90 dB
30.0 GHz	>34 dB	>30 dB	>34 dB	>85 dB
40.0 GHz	>34 dB	>28 dB	>34 dB	>81 dB
60.0 GHz	>26 dB	>24 dB	>26 dB	>60 dB

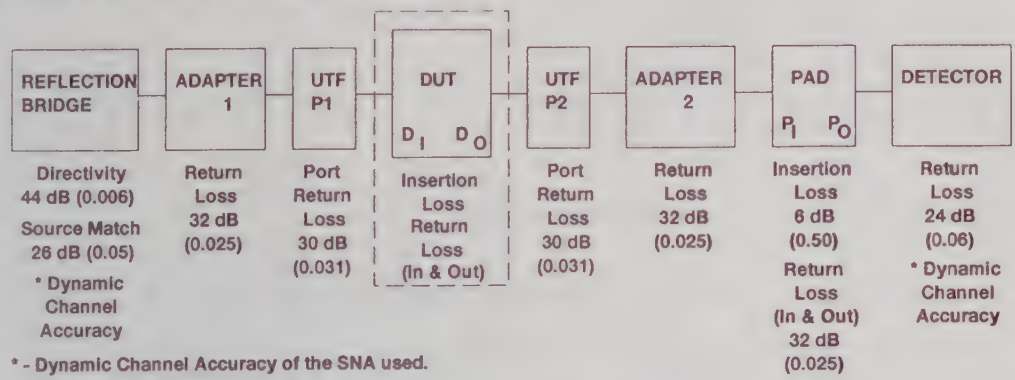
*36804B-10M (0.01-60 GHz); 36804B-15M (0.01-30 GHz); 36804B-25M (0.01-15 GHz); 36804B-25C (0.01-20 GHz)

Table 1-1. Specifications for the 3680 Series Universal Test Fixture and Accessories (2 of 3)

EXPECTED ACCURACY

When Used with a Scalar Network Analyzer

Typical SNA Measurement Errors at 10 GHz (Frequency Response Normalized):
Examples of typical amplitude coefficient values are shown for calculation purposes. Convert to dB using the RF Measurement Chart on page 1-5.
NOTE: Errors in series add; interaction errors multiply.



* - Dynamic Channel Accuracy of the SNA used.

Overall Coaxial Return Loss Measurement Uncertainty (Worst Case Analysis):

$$\text{Effective Directivity Error} = \text{Reflection Bridge Directivity} + \text{Adapter 1 Return Loss} + \text{UTF}^{①}\ \text{Port 1 Return Loss} = \begin{array}{l} 0.006 + 0.025 + 0.031 = 0.062 \text{ or } 24 \text{ dB (With Adapter)} \\ 0.006 + 0.031 = 0.037 \text{ or } 29 \text{ dB (Without Adapter)} \end{array}$$

① *UTF Port Return Loss = UTF Return Loss – 6 dB.*

$$\text{Effective Source Match Error}^{②} = \left[\text{Reflection Bridge Source Match} + \text{Adapter1 Return Loss} + \text{UTF Port1 Return Loss}\right] \times \left[\text{DUT } D_I \text{ Return Loss}\right]^2$$

$$= (0.05 + 0.025 + 0.031) \times (1.0)^2 = 0.106 \text{ (Fully Reflective DUT)}$$
$$= (0.05 + 0.025 + 0.031) \times (0.10)^2 = 0.001 \text{ (DUT With 20 dB Return Loss)}$$

② *Source match error is influenced by the return loss of the DUT and is maximum when the DUT is fully reflective.*

$$\text{Effective Termination Error}^{③} = \left[\text{UTF Port 2 Return Loss} + \text{Adapter 2 Return Loss} + \text{Pad } P_I \text{ Return Loss} + \left(\text{Pad Insertion Loss}\right)^2 \times \left(\text{Pad } P_O \text{ Return Loss} + \text{Detector Return Loss}\right)\right] \times \left[\text{DUT Insertion Loss}\right]^2$$

$$= [0.031 + 0.025 + 0.025 + (0.50)^2 \times (0.025 + 0.06)] \times (1.0)^2 = 0.102 \text{ or } 20 \text{ dB (DUT With No Insertion Loss)}$$

③ *Termination error is influenced by the insertion loss of the DUT.*

$$\text{Return Loss Uncertainty} = \text{Directivity Error} + \text{Source Match Error} + \text{Termination Error} + \text{Dynamic Channel Accuracy} = 0.06 + 0.001 + 0.102 + 0\ 0112 = \pm 0.174 \text{ or } \pm 15 \text{ dB}$$

Table 1-1. Specifications for the 3680 Series Universal Test Fixture and Accessories (3 of 3)

EXPECTED ACCURACY (Continued)

When Used with a Scalar Network Analyzer

Overall Insertion Loss Uncertainty (with examples):

$$\text{Insertion Loss Uncertainty} = \text{Interaction Errors} + \text{Dynamic Channel Accuracy}$$

$$\text{Insertion Loss Uncertainty} = \left[\text{Source Match Error} \times \text{DUT Match}\right] + \left[\text{Source Match Error} \times \text{Load Match Error} \times \left(\text{DUT Loss}\right)^2\right] + \left[\text{DUT Match} \times \text{Load Match Error}\right] + \text{Dynamic Channel Accuracy}$$

Examples:

1. If the DUT Loss = 40 dB (0.01) and the DUT Match = 20 dB (0.10), then:

$$\text{Insertion Loss Uncertainty} = [0.10 \times 0.10] + [0.10 \times 0.10 \times (0.01)^2] + [0.10 \times 0.10] + 0.03 = \pm 0.05 \text{ or } \pm 0.42 \text{ dB}$$

(Dynamic channel accuracy is the largest error.)

2. If the DUT Loss = 0 dB (1.0) and the DUT Match is perfect, then:

$$\text{Insertion Loss Uncertainty} = \left(\text{Source Match Error} \times \text{Load Match Error}\right) + \text{Dynamic Channel Accuracy} = (0.10 \times 0.10) + 0.01 = \pm 0.02 \text{ or } \pm 0.17 \text{ dB}$$

NOTES:

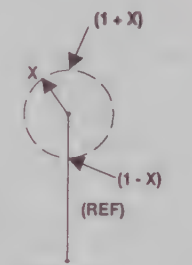
The above are worst case error examples of typical values at 10 GHz.
Typical results are root sum square and are substantially better.
If guaranteed specification values are used, especially high frequency specification values, the uncertainty can be substantially worse.

General Rules to Improve Accuracy:

1. Do not use adapters.
2. Use a pad at the detector for low-loss insertion loss measurements.
3. Use the best possible termination for reflection measurements, especially when the DUT is very low loss.

Table 1-2. RF Measurement Chart

Conversion tables for Return Loss, Reflection Coefficient, and SWR with tablular values for interaction of a small phasor x with a large phasor (unity reference) expressed in dB related to reference.



PHASOR INTERACTION

TERM002.DRW

SWR	Reflection Coefficient	Return Loss (dB)	Relative to Unity Reference			
			X dB Below Reference	REF + X dB	REF – X dB	REF ± X Peak to Peak Ripple dB
17.3910	0.8913	1	1	5.5350	–19.2715	24.8065
8.7242	0.7943	2	2	5.0780	–13.7365	18.8145
5.8480	0.7079	3	3	4.6495	–10.6907	15.3402
4.4194	0.6310	4	4	4.2489	–8.6585	12.9073
3.5698	0.5623	5	5	3.8755	–7.1773	11.0528
3.0095	0.5012	6	6	3.5287	–6.0412	9.5699
2.6146	0.4467	7	7	3.2075	–5.1405	8.3480
2.3229	0.3981	8	8	2.9108	–4.4096	7.3204
2.0999	0.3548	9	9	2.6376	–3.8063	6.4439
1.9250	0.3162	10	10	2.3866	–3.3018	5.6884
1.7849	0.2818	11	11	2.1567	–2.8756	5.0322
1.6709	0.2512	12	12	1.9465	–2.5126	4.4590
1.5769	0.2239	13	13	1.7547	–2.2013	3.9561
1.4935	0.1995	14	14	1.5802	–1.9331	3.5133
1.4326	0.1778	15	15	1.4216	–1.7007	3.1224
1.3767	0.1585	16	16	1.2778	–1.4988	2.7766
1.3290	0.1413	17	17	1.1476	–1.3227	2.4703
1.2880	0.1259	18	18	1.0299	–1.1687	2.1986
1.2528	0.1122	19	19	0.9237	–1.0337	1.9574
1.2222	0.1000	20	20	0.8279	–0.9151	1.7430
1.1957	0.0891	21	21	0.7416	–0.8108	1.5524
1.1726	0.0794	22	22	0.6639	–0.7189	1.3828
1.1524	0.0708	23	23	0.5941	–0.6378	1.2319
1.1347	0.0631	24	24	0.5314	–0.5661	1.0975
1.1192	0.0562	25	25	0.4752	–0.5027	0.9779
1.1055	0.0501	26	26	0.4248	–0.4466	0.8714
1.0935	0.0447	27	27	0.3796	–0.3969	0.7765
1.0829	0.0398	28	28	0.3391	–0.3529	0.6919
1.0736	0.0355	29	29	0.3028	–0.3138	0.6166
1.0653	0.0316	30	30	0.2704	–0.2791	0.5495
1.0580	0.0282	31	31	0.2414	–0.2483	0.4897
1.0515	0.0251	32	32	0.2155	–0.2210	0.4365
1.0458	0.0224	33	33	0.1923	–0.1967	0.3890
1.0407	0.0200	34	34	0.1716	–0.1751	0.3467
1.0362	0.0178	35	35	0.1531	–0.1558	0.3090
1.0322	0.0158	36	36	0.1366	–0.1388	0.2753
1.0287	0.0141	37	37	0.1218	–0.1236	0.2454
1.0255	0.0126	38	38	0.1087	–0.1100	0.2187
1.0227	0.0112	39	39	0.0969	–0.0980	0.1949
1.0202	0.0100	40	40	0.0864	–0.0873	0.1737
1.0180	0.0089	41	41	0.0771	–0.0778	0.1548
1.0160	0.0079	42	42	0.0687	–0.0693	0.1380
1.0143	0.0071	43	43	0.0613	–0.0617	0.1230
1.0127	0.0063	44	44	0.0546	–0.0550	0.1096
1.0113	0.0056	45	45	0.0487	–0.0490	0.0977
1.0101	0.0050	46	46	0.0434	–0.0436	0.0871
1.0090	0.0045	47	47	0.0387	–0.0389	0.0776
1.0080	0.0040	48	48	0.0345	–0.0346	0.0692
1.0071	0.0035	49	49	0.0308	–0.0309	0.0616
1.0063	0.0032	50	50	0.0274	–0.0275	0.0549
1.0057	0.0028	51	51	0.0244	–0.0245	0.0490
1.0050	0.0025	52	52	0.0218	–0.0218	0.0436
1.0045	0.0022	53	53	0.0194	–0.0195	0.0389
1.0040	0.0020	54	54	0.0173	–0.0173	0.0347
1.0036	0.0018	55	55	0.0154	–0.0155	0.0309
1.0032	0.0016	56	56	0.0138	–0.0138	0.0275
1.0028	0.0014	57	57	0.0123	–0.0123	0.0245
1.0025	0.0013	58	58	0.0109	–0.0109	0.0219
1.0022	0.0011	59	59	0.0097	–0.0098	0.0195
1.0020	0.0010	60	60	0.0087	–0.0087	0.0174

1-5 COMPONENT DESCRIPTIONS

The following is a list and description of the components that make up the UTF. Refer to Figure 1-2 for the location of these components.

RF Connectors – Each UTF model has a different RF connector type installed. The types installed are:

- 3.5 mm Connector that supports testing from DC to 20 GHz (Model 3680-20).
- K Connector that supports testing from DC to 40 GHz (Model 3680K).
- V Connector that supports testing from DC to 60 GHz (Model 3680V).

The RF connectors have a front side where the external RF connection is made, and a back side which contains a center conductor pin. This center conductor pin makes a spring-loaded pressure contact with the strip conductor of the substrate. The tip of the center conductor pin extends beyond the jaws, allowing visual alignment of the substrate into the fixture. The center conductor pins of the K Connector and V Connector have different designs (see Section 6–Applications, paragragh 6-2). The RF connectors are field replaceable.

Base – The support platform of the test fixture.

Fixed Connector Block – The RF connector assembly that is firmly attached to the base.

Sliding Connector Block – The RF connector assembly which slides along the slide rods and allows adjustment for the length of the substrate. The slide lock screw locks this block in position.

Slide Rods – The rods that support the sliding connector block.

Offset Block – The assembly that holds the sliding rods and allows the RF connectors to be offset axially ±1/2" (±1" for Model 3680-20). The offset lock screw fixes the position of this block.

Dielectric Spacer Rods – Used to space the substrate away from the connector block the precise distance required to compensate for the interface fringing capacitance. There are two dielectric rods behind each set of jaw plates. They are optimized for 10 mil substrates.

Levers – Used to open the lower jaws. Closing of the lower jaws is controlled by spring pressure.

Jaws – The plates which clamp the substrate in position and provide the proper ground connections. They consist of the Fixed Upper Jaw and the Movable Lower Jaw.

a. Fixed Upper Jaw – The jaw which provides the stop that sets the correct pressure between the RF connector center conductor pin and the substrate strip conductor. The upper jaw also provides the ground connection when used with CPW. The upper jaw is adjustable and is aligned using the Alignment Block.

There are two types of upper jaws; one for microstrip and one for CPW. The microstrip upper jaw has two connector configurations; a semicircle configuration for most applications and a slot configuration for very narrow microstrip measurements. The UTF comes from the factory with microstrip upper jaws installed. The CPW upper jaws come as part of the CPW calibration kit.

b. Movable Lower Jaw – The jaw that is opened by the levers. It provides the spring loaded clamping of the substrate to the connector blocks. The lower jaw provides the proper ground for microstrip substrates.

NOTE

The UTF comes with a thin sheet metal jaw separator installed between the upper and lower jaws. This relieves the pressure on the connector pin. It is good practice to install the separator whenever the UTF will not be used for a long period of time or is placed in storage. When installing the jaw separator, position it off center so that it does not contact the connector pin.

Substrate Stop – An adjustable stop which can be used to accurately position substrates of the same width.

Alignment Block – (Not Shown) Used to precisely position the upper jaw of a connector block when the upper jaw is changed or adjusted.

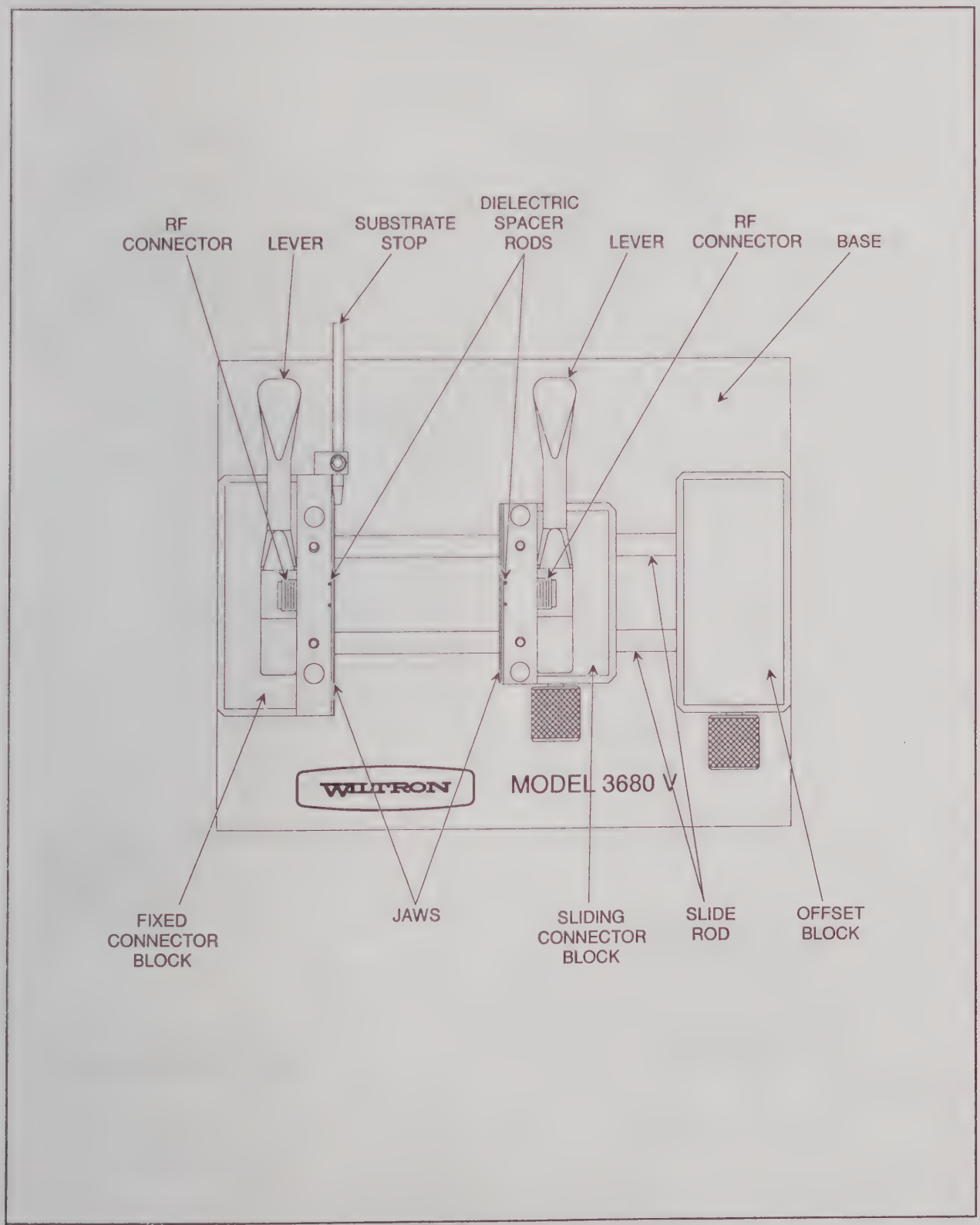


Figure 1-2. 3680 Series Universal Test Fixture Components

SECTION II
OPERATION

2-1 INTRODUCTION

The UTF can be used with either scalar network analyzer (SNA) or vector network analyzer (VNA) systems. This section provides the information required to configure and operate the systems with a UTF. Included are procedures for equipment setup and substrate mounting as well as information regarding calibration requirements and measurement considerations.

2-2 OPERATION WITH SCALAR NETWORK ANALYZER SYSTEMS

The following steps are necessary to use the UTF with SNA systems.

NOTE

Use of a microscope is recommended.

a. Calibration

Calibrate and normalize the SWR Autotester (reflection bridge) and the RF Detector in the normal manner for coax. If possible, connect a 6 dB attenuator to the detector to improve the load match. The insertion loss can be normalized with the UTF in place but this may cause ripples in low insertion loss measurements. The typical loss of each UTF connector is approximately 0.25 db at 40 GHz and 0.4 dB at 60 GHz.

b. Equipment Setup

Refer to Figure 2-1. Connect the UTF to the SNA system as follows:

1. Connect the fixed connector of the test fixture to the SWR Autotester.
2. Connect the sliding connector of the test fixture to the RF detector or termination.
3. Torque the connectors to 5 inch/pounds (8 inch/pounds maximum).

c. Substrate Mounting Procedure

Clamp the substrate into the connectors of the UTF as follows:

1. On the UTF, open the fixed connector block jaw and center the center conductor of the substrate directly under the connector pin. Allow the jaw to clamp the substrate.
2. Open the sliding connector block jaw and adjust the sliding connector block to allow the substrate to contact the connector.

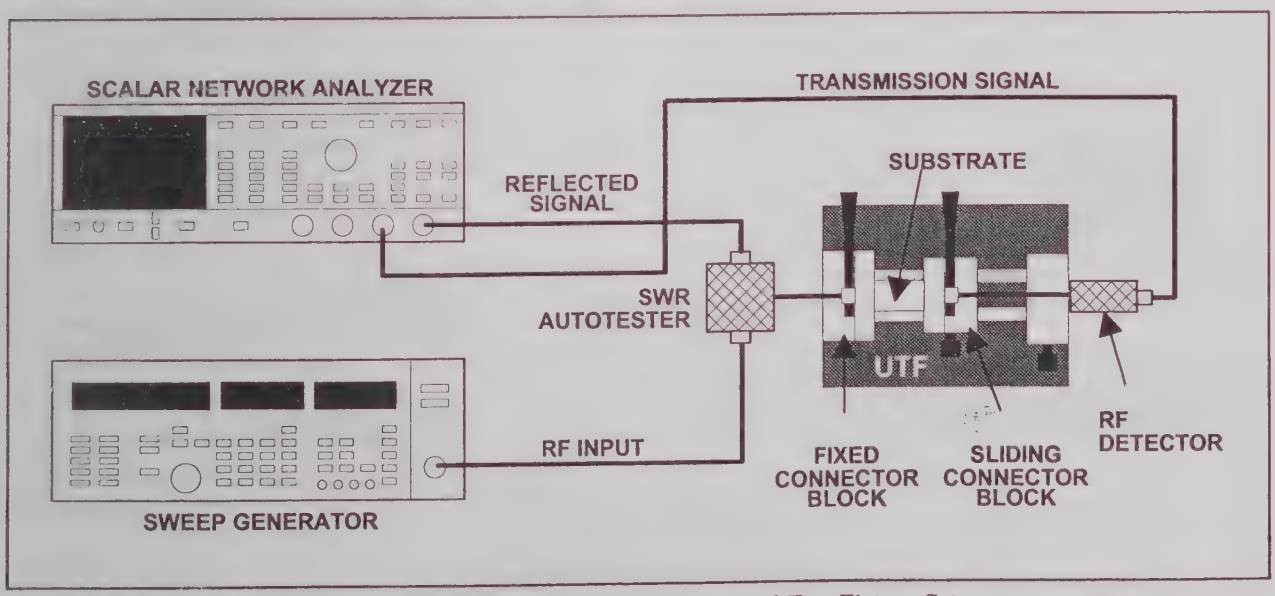


Figure 2-1. Scalar Network Analyzer/Universal Test Fixture Setup

NOTE

It may be necessary to push the substrate slightly downward to allow the substrate to slip under the upper jaw.

3. Insure that the connector pin of the movable jaw is directly over the substrate strip conductor. Allow the jaw to clamp the substrate.

NOTE

If desired, lock the sliding jaw in position. (This is not an absolute necessity).

4. If the substrate conductor does not line up with the connector pin, adjust the offset block as follows:

(a) Loosen the offset block lock screw until the block moves smoothly; it is spring loaded.

(b) Move the sliding connector block toward the substrate until it almost touches the substrate.

(c) Move the offset block to the proper location and retighten the lock screw. Tighten the lock screw only enough to prevent the offset block from moving.

d. Measurement

Make the desired test substrate measurements.

2-3 OPERATION WITH VECTOR NETWORK ANALYZER SYSTEMS

The following steps are necessary to use the UTF with VNA systems.

NOTE

Use of a microscope is recommended.

CAUTION

Before connecting the UTF to a VNA Active Device Test Set, ***always*** disconnect or turn off any bias input(s) to the test set. ***Never*** apply bias input(s) to the test set when the UTF jaws are empty. Failure to do so can result in damage to the test set.

a. Equipment Setup

Refer to Figure 2-2. Connect the UTF to the VNA setup as follows:

1. Using a one foot cable, connect the fixed connector of the test fixture to Port 1 of the VNA.
2. Using a two foot cable, connect the sliding connector of the test fixture to Port 2 of the VNA.
3. Torque the connectors to 5 inch/pounds (8 inch/pounds maximum).

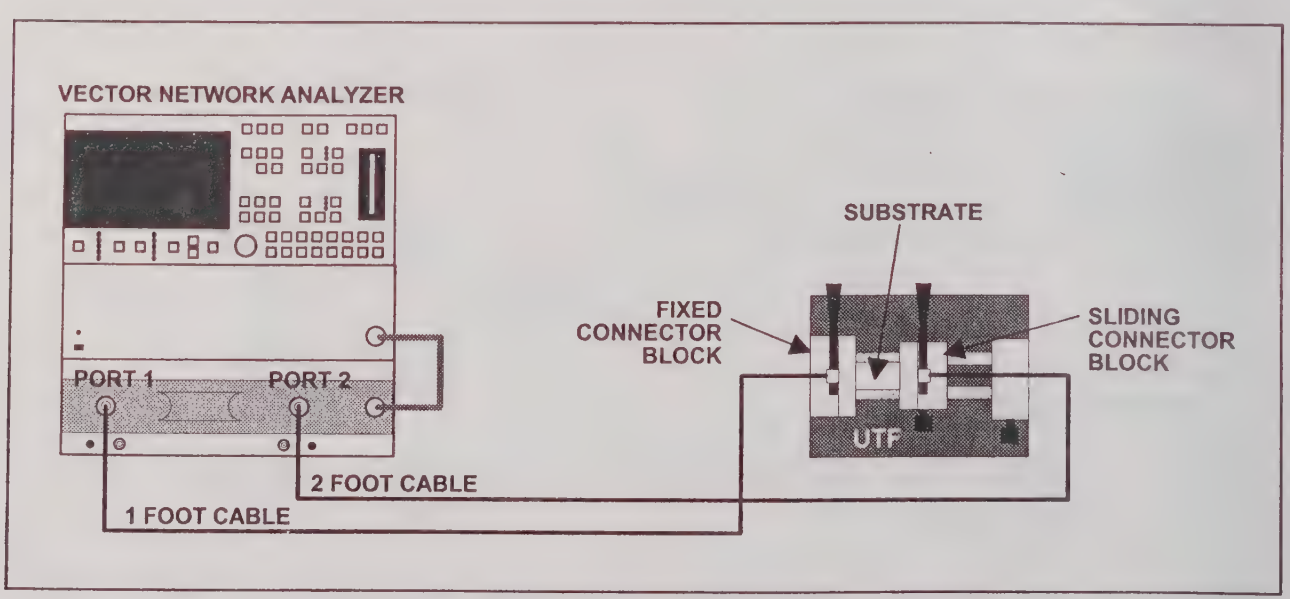


Figure 2-2. Vector Network Analyzer/Universal Test Fixture Setup

b. Substrate Mounting Procedure

Clamp the substrate into the connectors of the UTF as follows:

1. On the UTF, open the fixed connector block jaw and center the strip conductor of the substrate under the connector pin. Allow the jaw to clamp the substrate.
2. Open the sliding connector block jaw and adjust the sliding connector block to allow the substrate to contact the connector pin.

NOTE

It may be necessary to push the substrate slightly downward to allow the substrate to slip under the upper jaw.

3. Insure that the connector pin of the movable jaw is directly over the substrate conductor. Allow the jaw to clamp the substrate.

NOTE

If desired, lock the sliding jaw in position. (This is not an absolute necessity).

4. If the substrate center conductor does not line up with the connector pin, adjust the offset block as follows:

(a) Loosen the offset block lock screw until the block moves smoothly; it is spring loaded.

(b) Move the sliding connector block toward the substrate until it almost touches the substrate.

(c) Move the offset block to the proper location and retighten the lock screw. Tighten the lock screw only enough to prevent the offset block from moving.

c. Calibration

VNA systems require calibration for accurate operation. Using the appropriate UTF calibration kit for microstrip or CPW, calibrate the VNA system following the procedures in Section 3 – Calibration.

d. Measurement

Once the VNA system has been calibrated, clamp the substrate to be tested into the UTF and make the desired measurements.

CAUTION

When testing substrates that require bias voltage, ***always*** disconnect or turn off any bias input(s) to the VNA test set before removing the substrate from the UTF jaws. ***Never*** apply bias input(s) to the test set when the UTF jaws are empty. Failure to do so can result in damage to the test set.

2-4 CPW MEASUREMENT CONSIDERATIONS

For proper launching and high frequency propagation, there must be no metal (ground plane) on the bottom side of the CPW substrate. Performance is enhanced by placing the substrate on a slab of dielectric. Even under these conditions the substrates tend to mode at various frequencies. The CPW calibration kit uses 25 mil alumina substrates with no ground plane on the far side. These substrates are mounted on 30 mil epoxy glass carriers with mode absorbing material mounted on the bottom side of the carrier.

Another difficulty with mounting CPW substrate is the requirement of four ground points. The use of the standard rigid jaws places almost impossible demands on planarity. The UTF uses special upper jaws for CPW measurement; the ground contact points are spring loaded and the narrow pin slot permits grounding at the correct location. The CPW upper jaws are included as part of the CPW calibration/verification kit (Anritsu Model 36804B-25C).

When making CPW measurements, it is recommended that the substrate be mounted on 1/32 inch epoxy glass carriers and that mode suppression be added as required.

Microstrip measurements can be made with the CPW upper jaws, but they should be limited to frequencies below 26 GHz. Performance is reduced because of the excess capacitance of the narrow slot. SNA measurements will be significantly degraded.

CPW measurements can be made using the microstrip upper jaws, but the frequency should be limited to below 8 GHz and the jaw planarity must be adjusted very carefully.

2-5 MEASUREMENTS OF SUBSTRATE MOUNTED ON CARRIERS

Substrates mounted on carriers are not measured as accurately as non-carrier mounted substrates. This is because VNA system calibration is performed using the non-carrier mounted precision substrates in the calibration kits. As a result, the interface correction will be different. In general, the thinner the carrier, the less negative the effect. Carriers must be flat; bowed carriers will cause grounding problems.

CAUTION

Narrow substrates mounted on carriers can cause damage to the UTF if the substrate is narrower than the 0.09" (2.3 mm) semicircle connector configuration of the upper jaw. If a narrow substrate must be measured, use the narrow slot connector configuration of the upper jaw (see paragraph 4-2a).

2-6 USE OF THE SUBSTRATE STOP

The substrate stop is used to accurately position substrates of the same width. Adjust the stop as follows:

1. Loosen the holding screw and move the stop to the desired location.
2. Place a substrate into the UTF jaws and lightly press the stop against the side of the substrate.
3. Tighten the holding screw finger tight.

SECTION III
CALIBRATION

3-1 INTRODUCTION

This section contains calibration information and procedures that apply to VNA systems only. SNA systems should be calibrated and normalized prior to connection to the UTF (see Section 2, paragraph 2-2a).

3-2 GENERAL INFORMATION

Calibration of a VNA connected to a UTF can be performed directly in microstrip or CPW. This calibrates out the mismatch that results from the transition between coax to microstrip or CPW. Beginning the calibration procedure requires the selection of the appropriate calibration kit and calibration method. Four calibration kit models are available for use with the UTF (paragraph 3-3).

Three calibration methods are available; Open-Short-Load (OSL), Line-Reflect-Line (LRL), and Line-Reflect-Match (LRM)*. LRM calibration is a variation of LRL calibration where a match (termination) is used in place of the second line.

LRL calibrations give the best accuracy but bandwidth is limited to approximately 10:1. The less accurate OSL and LRM calibrations cover wider frequency ranges and can calibrate down to lower frequencies. LRM calibration results in a better source match than OSL calibration, but only OSL calibration can perform a one-port calibration.

OSL calibrations are the least accurate type of calibration, especially for large reflections. If possible, an LRM calibration should be used because it has advantages in accuracy and ease of use. OSL calibrations require open calibration coefficient values to properly define the open standard. The open calibration coefficient values are included with each UTF calibration kit.

The best wide band calibration can be obtained by combining an LRL calibration with an LRM calibration. This is also the recommended calibration method when the Lowpass Mode of time domain measurement is desired. Very accurate calibrations covering 0.01 to 60 GHz can be obtained using this method. Refer to paragraph 3-4 for the OSL, LRL, and LRM calibration procedures.

3-3 CALIBRATION/VERIFICATION KITS

The UTF calibration/verification kits contain precision substrates of precisely known impedances for both OSL, LRL, and LRM calibrations. The kits also contain verification substrates for use in confirming the calibration accuracy. These verification substrates are a Beatty Line and an offset termination line. Table 3-1 shows the calibration/verification kits available for use with the UTF, their model numbers, substrate type, and frequency coverage.

Table 3-1. UTF Calibration/Verification Kits

Model	Substrate Type	Frequency
36804B-10M	10 mil (0.25 mm) Microstrip	0.01-60 GHz
36804B-15M	15 mil (0.38 mm) Microstrip	0.01-30 GHz
36804B-25M	25 mil (0.63 mm) Microstrip	0.01-15 GHz
36804B-25C	25 mil (0.63 mm) CPW	0.01-20 GHz

Each calibration/verification kit contains the following components:

Termination, Dual Ends, Broad Band
Open-Short, 0.5 cm long
Beatty Line, 30 ohm
Offset Termination
LRL Lines (Models 36804B-10M,-15M, and -25M):
- 1.00 cm, Line One, Reference
- 1.07 cm, 6-60 GHz
- 1.10 cm, 4-40 GHz
- 1.20 cm, 2-20 GHz
- 1.70 cm, 0.5-5 GHz

LRL Lines (Model 36804B-25C):
- 1.00 cm, Line One, Reference
- 1.08 cm, 10-60 GHz (Not generally used)
- 1.12 cm, 6-40 GHz
- 1.30 cm, 3-20 GHz
- 1.90 cm, 0.5-5 GHz

In addition, the Model 36804B-25C CPW calibration/verification kit contains the special upper jaws for CPW measurement.

* LRM Calibration Method of Rhode & Scharwz, Germany

3-4 CALIBRATION FOR MICROSTRIP

The following LRL, LRM, and OSL calibration procedures support the Anritsu Model 360B and 372XXA VNAs.

NOTE

For calibration of 360B VNAs having software versions earlier than version 4.01 or for calibrations using the series 36804 UTF Calibration/Verification kits instead of the series 36804B kits, consult the addendum at the end of this section.

a. Line-Reflect-Line Calibration

To perform an LRL calibration of the VNA for microstrip, proceed as follows:

1. Select the desired LRL line substrates from the appropriate microstrip calibration kit. When called for in the calibration sequence, mount the LRL line substrates on the UTF following the procedure in paragraph 2-3c.
2. On the VNA:
   (a) Press the BEGIN CAL key.
   (b) Select CHANGE CAL METHOD AND LINE TYPE.
   (c) Select LRL/LRM and MICROSTRIP.
   (d) Continue through the calibration sequence selecting:
      (1) CALIBRATION TYPE
      (2) ISOLATION
      (3) DATA POINTS
      (4) FREQUENCY RANGE
   (e) When the CONFIRM CALIBRATION PARAMETERS menu is reached;
      (1) Select CHANGE MICROSTRIP PARAMETERS, then select the UTF calibration kit (10 MIL KIT, 15 MIL KIT, or 25 MIL KIT) from the menu.
      (2) Select CHANGE LRL/LRM PARAMETERS and select ONE BAND or TWO BANDS (refer to paragraph 3-4c).
      (3) Select CHANGE LRL/LRM PARA-METERS and select the LOCATION OF REFERENCE PLANES.
      (4) Select CHANGE LRL/LRM PARAMETERS and CHARACTERIZE CAL DEVICES;
         - For DEVICE 1, enter the length of LINE 1 (typically 1.00 cm).
         - For DEVICE 2, select LINE, then enter the length of the line (depends on the frequency range).
         - If TWO BANDS was selected in step 2.(e)(2), then for DEVICE 3, select LINE and enter the length of the line.
         - If TWO BANDS was selected in step 2.(e)(2), then enter the BREAKPOINT frequency in GHz.
      (5) Select CHANGE LRL/LRM PARA-METERS, then NEXT CAL STEP and OFFSET LENGTH OF RELECTIVE DEVICE [The user may at his option use either the Open/Short Offset standard included in the calibration kit with the associated offset length of 0.5 cm or the jaws open or closed (short) with an offset length of 0.0000 mm. A short with the jaws closed is easiest to use and is therefore recommended.];
         - Enter OFFSET LENGTH (typically 0.0000 mm).
         - Select TYPE OF REFLECTION (typically LESS THAN Z_0).
      (6) Select START CAL, then press ENTER.
3. Continue the calibration sequence, following the prompts. Mount the appropriate LRL line substrates when requested in the calibration sequence.
   (a) ISOLATION DEVICE is requested if ISOLATION was selected in the calibration sequence. This is usually a temination; but, in some applications it is more convenient to use a reflection standard.
4. Store the calibration.

b. Line-Reflect-Match Calibration

LRM calibration is a variation of LRL calibration where a termination is substituted for line 2. LRM calibration can cover the same wide bandwidth as OSL calibration but LRM calibration results in a better source match.

To perform an LRM calibration of the VNA for microstrip, proceed as follows:

1. On the VNA:
   (a) Press the BEGIN CAL key.
   (b) Select CHANGE CAL METHOD AND LINE TYPE.
   (c) Select LRL/LRM and MICROSTRIP.
   (d) Continue through the calibration sequence selecting:
      (1) CALIBRATION TYPE
      (2) ISOLATION
      (3) DATA POINTS
      (4) FREQUENCY RANGE
   (e) When the CONFIRM CALIBRATION PARAMETERS menu is reached;
      (1) Select CHANGE MICROSTRIP PARAMETERS, then select the UTF calibration kit (10 MIL KIT, 15 MIL KIT, or 25 MIL KIT) from the menu.
      (2) Select CHANGE LRL/LRM PARA-METERS and select ONE BAND or TWO BANDS (refer to paragraph 3-4c).
      (3) Select CHANGE LRL/LRM PARA-METERS and select the LOCATION OF REFERENCE PLANES.
      (4) Select CHANGE LRL/LRM PARA-METERS and CHARACTERIZE CAL DEVICES;
         - For DEVICE 1, enter the length of LINE 1 as 1.00 cm.
         - For DEVICE 2, select MATCH.
         - If TWO BANDS was selected in step 1.(e)(2), then for DEVICE 3, select LINE and enter the length of the line.
         - If TWO BANDS was selected in step 1.(e)(2), then enter the BREAKPOINT frequency in GHz.
      (5) Select CHANGE LRL/LRM PARA-METERS, then NEXT CAL STEP and OFFSET LENGTH OF REFLECTIVE DEVICE [The user may at his option use either the Open/Short Offset standard included in the calibration kit with the associated offset length of 0.5 cm or the jaws open or closed (short) with an offset length of 0.0000 mm. A short with the jaws closed is easiest to use and is therefore recommended.];
         - Enter OFFSET LENGTH (typically 0.000 mm). (Use the lower jaw of the UTF to short the connector.)
         - Select TYPE OF REFLECTION (typically LESS THAN Z_0).
      (6) Select START CAL, then press ENTER.
2. Continue the calibration sequence, following the prompts. Mount the appropriate line substrates when requested in the calibration sequence.
   (a) ISOLATION DEVICE is requested if ISOLATION was selected in the calibration sequence. This is usually a temination; but, in some applications it is more convenient to use a reflection standard.
3. Store the calibration.

c. Three-Line LRL Calibration and Combined LRL & LRM Calibration

Three-line LRL calibration is available for wide bandwidth application (>10:1). Three-line LRL calibration allows concatenation of two LRL calibrations or an LRL and an LRM calibration. The selection between two- or three-line LRL calibrations is made from the CHANGE LRL/LRM PARAMETERS menu.

In general, the first line (Device 1) is always the 1.0 cm LRL line, the second line (Device 2) is the low frequency LRL line (or the match for LRM), and the third line (Device 3) is the high frequency (short) LRL line. For a combined LRL and LRM calibration, the second line (Device 2) is set to match and the dual termination is used instead of an LRL line. The three-line LRL calibration also asks for the breakpoint between the two calibrations. For two LRL calibrations, select as breakpoint the upper fre-

quency of the low frequency LRL line. For a combined LRL and LRM calibration, select as breakpoint the top frequency of the calibration divided by six; for instance, to cover the frequency range 0.04 to 60 GHz, select 10 GHz as the breakpoint.

d. Open-Short Load Calibration

To perform an OSL calibration of the VNA for microstrip, proceed as follows:

1. Select the appropriate microstrip calibration kit. When called for in the calibration sequence, mount the appropriate substrate on the UTF following the procedure in paragraph 2-3c.
2. On the VNA:
   (a) Press BEGIN CAL key.
   (b) Select CHANGE CAL METHOD AND LINE TYPE.
   (c) Select STANDARD and MICROSTRIP.
   (d) Continue through the calibration sequence selecting:
      (1) CALIBRATION TYPE
      (2) ISOLATION
      (3) DATA POINTS
      (4) FREQUENCY RANGE
   (e) When the CONFIRM CALIBRATION PARAMETERS menu is reached;
      (1) Select CONNECTOR TYPE (One or two ports as required).
      (2) Select USER DEFINED and enter the coefficients supplied with the calibration kit. Be sure to enter the values for both the open and the short.
      (3) Select BROADBAND LOAD.
      (4) Select CHANGE MICROSTRIP PARAMETERS. Enter the appropriate microstrip parameters (listed in the calibration kit data). Press ENTER when complete.
      (5) Select START CAL, then press ENTER.
3. Continue the calibration sequence, following the prompts. Mount the appropriate calibration kit substrate when requested in the calibration sequence.
4. Store the calibration.

e. Recalibration with the Stored Calibration

When a new calibration is desired, recall the stored calibration, make any required minor changes, and recalibrate. All of the stored calibration coefficients will be in the new calibration.

3-5 CALIBRATION FOR CPW

Before calibration of the VNA for CPW can begin, the microstrip upper jaws of the UTF must be replaced with the CPW jaws. The CPW upper jaws are included in the CPW calibration kit. After replacing the upper jaws of the UTF, adjust them using the adjustment procedure in paragraph 4-2.

NOTE

The CPW upper jaws must be installed to the UTF connector blocks as shown in Figure 3-1.

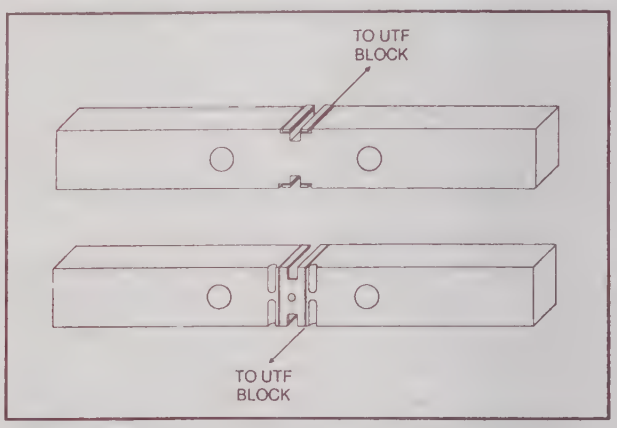


Figure 3-1. CPW Jaw Installation

The VNA does not address measurement and calibration of CPW specifically; however, using microstrip parameters gives good results when the following guidelines are followed. The dimensions suggested in steps 1.(a)(1) and 1.(a)(2) are smaller than the actual CPW calibration kit parameters. This compensates for the fact that CPW is much less dispersive than microstrip.

1. Follow the OSL or LRL calibration procedures in paragraph 3-4. When the CONFIRM CALIBRATION PARAMETERS menu is reached;
   (a) Select CHANGE MICROSTRIP PARAMETERS, then select USER DEFINED. The USER DEFINED MICROSTRIP PARAMETERS menu is then displayed. Enter the following parameters;
      (1) WIDTH OF STRIP: 0.2500 mm

(2) THICKNESS OF SUBSTRATE: 0.2500 mm

(3) Z_C: 50.000 Ω

(4) EFFECTVE DIELECTRIC: 5.1

(5) Press ENTER

2. Continue the calibration sequence, following the procedures in paragraph 3-4 and the system prompts. Mount the appropriate substrate from the CPW calibration kit when requested in the calibration sequence.

3. Store the calibration.

The CPW calibration kit is specified to 20 GHz. It can be used to 40 GHz, although special precautions may be necessary to prevent moding.

3-6 CALIBRATION CHECKS

There are three general techniques for checking the accuracy of a calibration:

1. Measurement of calibration standards
2. Measurement of known standards
3. Measurement of assurance standards

The calibration kits contain components for all three techniques.

a. Measurement of Calibration Standards

The simplest, least accurate technique is to measure the calibration standards. This method is mainly a check of repeatability and is only as accurate as the calibration standards.

NOTE

Technique is very important for good results.

To perform calibration checks by measuring calibration standards, proceed as follows:

1. After calibration, mount one of the calibration standards (an LRL line for LRL calibrations or a termination for OSL calibrations) on the UTF following the procedure in paragraph 2-3c. Be sure to mount the substrate in the same orientation as during calibration.

2. On the VNA, measure S_{11} and S_{21}. The results should look good. The definition of *good* is dependent on frequency and past experience.

b. Measurement of Known Standards

This technique uses the Beatty Line as the known standard. In theory, a 30 ohm Beatty Line standard (1) gives a return loss of 6 dB and an insertion loss of 1.2 dB at each frequency that is an odd quarter wave multiple of its length and (2) appears as a standard 50 ohm line at each frequency that is â half wave multiple of its length. Microstrip is an imperfect medium for Beatty Line standards because it is lossy; the impedance changes with frequency and the low impedance line has a much lower cutoff frequency than the 50 ohm line. However, the results of measurements are very stable and the results of a good calibration will be repeatable.

To perform calibration checks by measuring a Beatty Line standard, proceed as follows:

1. Mount the 1.7 cm line on the UTF following the procedure in paragraph 2-3c.

2. On the VNA, use TRACE MEMORY-DIVIDE to subtract out the loss of the line. Then store the loss of the 1.7 cm line to trace memory.

3. Remove the 1.7 cm line from the UTF. Then mount the Beatty Line standard on the UTF and display data divided by memory.

4. On the VNA, measure S_{11} and S_{21}.

   (a) For S_{11}, the return loss should vary from approximately 7 dB to more than 20 dB. The depth of the nulls is a rough indication of the directivity.

   (b) For S_{21}, the insertion loss should vary between approximately 0 dB and –1 dB and should be regular. The insertion loss values are not the theoretical 1.2 dB because of line losses.

NOTE

Variations from a smooth sine wave are indications of an imperfect calibration.

c. Measurement of Assurance Standards

This is the most accurate technique for evaluating the accuracy of a calibration. It uses independent assurance components to measure the directivity and source match values. Directivity measurements are made using the offset termination while source match measurements are made using the 1.70 cm line. The technique uses a length of transmission line to separate the error vector from the DUT vector allowing a direct measurement of directivity and source match ①.

NOTE

Assurance lines give direct indication of the errors due to source match and directivity; the ripples are the *error window* and the actual values are calculated using the RF Measurement Chart.

To perform the source match assurance check, proceed as follows:

1. Mount the 1.7 cm line on the UTF following the procedure in paragraph 2-3c. Connect the 1.7 cm line to one port of the UTF, do *not* connect the other end.
2. On the VNA, observe S_{11} on a scale of approximately 1 dB. The open end of the line interacts with the source match to create a sine wave (ripple).
3. Measure the peak-to-peak amplitude of the ripple (source match error).
4. Convert the value of the source match error to dB using the RF Measurement Chart on page 1-5.
   (a) For example, if the ripples are 1 dB peak-to-peak the source match is 25 dB.

NOTE

Irregularities in the display which are not part of the regular sine wave should be ignored.

To perform the directivity assurance check, continue as follows:

5. Mount the offset termination on the UTF following the procedure in paragraph 2-3c. Connect the offset termination to the test port.
6. On the VNA, observe S_{11}. It should be a sine wave (ripple) centered approximately 20 dB down.
7. Measure both the average value of the ripple and the peak-to-peak amplitude of the ripple.
8. Convert the ripple peak-to-peak value to dB using the RF Measurement Chart on page 1-5 and add this value to the average value (dB down) of the ripple. This is the directivity.
   (a) For example, if the average value is 17 dB and the ripple is 2 dB peak-to-peak, the directivity is 17 dB + 19 dB = 36 dB.

① Source Match (SM) is defined here as the error due to a full reflection and is actually a combination of the True Source Match (T_{SM}) and Directivity (D) errors according to the equation:

$$SM = D + T_{SM} \times (DUT)^2$$

Thus the measured Source Match is the sum of the True Source Match and the Directivity.

Addendum

OSL Calibration Utilizing UTF Calibration Kits

Series 36804B UTF Calibration/Verification kits have been updated to allow for dispersion correction with 360B VNA systems. The open and short circuit coefficients sent with these new kits take into account microstrip dispersion. These changes only affect customers performing OSL calibrations in microstrip. The recommended LRM and LRL techniques are unchanged.

The 360B VNA compatibility matrix (below) is provided to assist you in selecting the proper UTF calibration kit and OSL calibration media type.

360B VNA Software Version	If User has Series 36804 Calibration Kit	Future Calibration Kit Purchases
3.06 and below	OK	Series 36804 Calibration Kit is no longer available. Order 10 Mil-SC4771 10 Mil-SC4772 10 Mil-SC4773
3.07 and 3.08	On the 360B VNA: Select Coaxial LIne Type (Instead of Microstrip) to disable dispersion correction.	Series 36804 Calibration Kit is no longer available. Order 10 Mil-SC4771 10 Mil-SC4772 10 Mil-SC4773 **AND** On the 360B VNA: Select Coaxial LIne Type (Instead of Microstrip) to disable dispersion correction.
4.00 amd 4.01	Free exchange to a Series 36804B Calibration Kit if still within the warranty period. Contact Customer Service **OR** On the 360B VNA: Select Coaxial LIne Type (Instead of Microstrip) to disable dispersion correction.	Must upgrade to 360B VNA Software Versiion 4.02
4.02 and above	Free exchange to a Series 36804B Calibration Kit if still within the warranty period. Contact Customer Service **OR** On the 360B VNA: Select Coaxial LIne Type (Instead of Microstrip) to disable dispersion correction.	Order: 36804B-10M 36804B-15M 36804B-25M

SECTION IV
MAINTENANCE

4-1 INTRODUCTION

This section provides instructions for maintaining the UTF. Maintenance requirements are limited to adjustment of the connector block upper jaws, removal and replacement of connectors, and preventive maintenance.

4-2 UPPER JAW ADJUSTMENT

The adjustment of the connector block upper jaws is critical to correct operation of the UTF. The upper jaw must be the exact distance above the center conductor pin to ensure the proper pin-to-substrate pressure contact. In addition, the upper jaws must be exactly parallel to each other for correct clamping action.

a. Jaw Types

There are two types of connector block upper jaws; one for microstrip and one for CPW. The microstrip upper jaw has two different connector configurations; a semicircle and a slot. The semicircle configuration is used for most applications. The slot configuration is used when making measurements of very narrow microstrip, but will degrade the scalar performance. The narrow slot configuration may also be used for CPW connection but adjusting planarity is difficult.

The CPW upper jaws come as part of the CPW calibration kit. The CPW upper jaws have spring contact fingers for good ground connection. The jaws have two different spring spacing widths; 0.032 in. and 0.040 in. Choose the spring spacing width that best fits the CPW being tested. The spring spacing for the standard CPW calibration kit is 0.032 in.

b. Adjustment Block

The UTF comes with an adjustment block that allows precise alignment of the upper jaws. The thickness of the adjustment block has been set for the UTF associated with it.

CAUTION

Do ***not*** remove the tape on the bottom of the adjustment block. The tape is used to shim the block to the exact dimension required by the UTF associated with it.

c. Adjustment Procedure

1. Required tools:

   Screwdriver, Phillips

2. Upper jaw adjustment:

   (a) Hold the lower jaw open during the adjustment by placing a toothpick under the back side of the lever, between the lever and the housing.

   (b) Chose the desired upper jaw configuration and mount in the UTF.

   (c) Loosely tighten the upper jaw screws, grasping and turning the screwdriver by its shaft to apply the tightening torque.

   (d) Place the adjustment block under the jaw at an angle.

   (e) Press the block down onto the rods levering the jaw upwards. When the block is sitting on the rods, the lower surface of the jaw should press evenly and snugly against it.

   (f) Tighten the upper jaw screws firmly. Do ***not*** over torque.

   (g) Inspect for proper connector pin movement per paragraph 4-3b.2.(h).

   (h) Repeat steps (a) thru (h) for the other upper jaw.

4-3 CONNECTOR REMOVAL AND REPLACEMENT

The connector is easily removed for cleaning and replacement. The most critical part of the connector is the small pin that contacts the substrate. It must be kept clean and accurately positioned. See paragraph 4-3 for routine cleaning instructions. If the pin becomes bent, broken, or very dirty, the connector must be removed to make the necessary repairs.

CAUTION

When removing or replacing a connector ***always*** keep the UTF jaws open. Failure to do so can result in damage to the connector pin.

a. Removal Procedure

1. Required tools:

   Wrenches, 5/16", 2 each
   Connector removal tools, barrel and stop

2. Connector removal:

   (a) Hold the UTF jaws open by placing the thin sheet metal jaw separator between the upper and lower jaws. (See the note on page 1-6).

   (b) Set the gap between the connector removal tool barrel and the stop to approximately 1/16 inch.

   (c) Screw the connector removal tool onto the connector and tighten it hand tight.

   (d) Place the wrenches on the connector removal tool barrel and the stop. Set the angle between them at approximately 45 degrees.

   (e) Squeeze the wrenches together firmly, using one hand. This is important to prevent torquing the housing of the UTF.

   (f) Use a wrench on the barrel to remove the connector. If the removal tool loosens, repeat the above step but squeeze the wrenches more firmly.

   NOTE

   The center conductor assembly can be removed from the outer conductor without removing the outer conductor from the connector removal tool.

   (g) Repair or replace the connector as required. When replacing the connector or connector pin, use the following Anritsu parts:

   3.5 mm & K Connector Pin – P/N B22849
   V Connector Pin – P/N B22490
   K Connector – P/N B22845
   V Connector – P/N B22848
   3.5 mm Connector – P/N B22846

   NOTE

   Be sure to reuse any tuning shim(s) which are on the small pin and any pin depth shim(s) which are between the center conductor and outer conductor.

b. Replacement Procedure

1. Required tools:

   Wrenches, 5/16", 2 each
   Connector removal tool, barrel and stop
   Torque wrench, 8 inch/pounds

2. Connector replacement:

   (a) Ensure that the UTF jaws are still held open.

   (b) Ensure that the outer conductor is still locked into the connector removal tool.

   (c) Install the center conductor assembly into the outer conductor.

   (d) Screw the connector hand tight into the UTF.

   (e) View the position of the pin in the hole of the connector block. The pin must be either centered or below center toward the lower jaw. The maximum that the pin can be off center is 1/3 the diameter of the pin. If it is off center by more than the maximum, the connector must be replaced. If the pin is off center by less than the maximum but its location is not toward the lower jaw, it must be adjusted. Note the pin's off center position, remove the connector from the UTF. Use a probe to rotate the center conductor assembly to the correct position and reinstall the connector in the UTF.

   CAUTION

   When replacing a connector on the UTF, do ***not*** over torque the connector. Over torquing can result in damage to the UTF.

   (f) Torque the connector to 8 inch/pounds.

   (g) Reinspect the pin for proper positioning. Adjust as required by repeating the above steps.

   (h) Insert a substrate into the UTF and test for correct pin-to-substrate contact by permitting the lower jaw to close while observing the pin. The pin should deflect a minimum of 1/3 its diameter and still be centered in the hole within 1/3 of its diameter. If this is not the case, the connector block upper jaw must be adjusted (See paragraph 4-2).

4-4 PREVENTIVE MAINTENANCE

a. UTF

The following preventive maintenance is recommended for the UTF:

1. Keep the areas in the vicinity of the substrate clean and free of material. Use a cotton swab, dampened with isopropyl alcohol, to clean these areas. Be careful not to distort the pin. Open the lower jaw while cleaning.
2. Keep the slide rods free of dirt. Clean them with an isopropyl alchohol dampened wipe. Rubbing the rods with your fingers will provide sufficient lubrication.

b. Calibration Kits

The following preventive maintenance is recor
mended for the calibration kits:

1. Keep the calibration substrates in the holde
except when in use.
2. Always handle the calibration substrates b
the side edges. *Avoid touching the ends.*
3. If the components of the calibration kits re
quire cleaning, use a swab dampened in iso
propyl alcohol.

SECTION V
OPTIONAL ACCESSORIES

5-1 INTRODUCTION

The UTF optional accessories are the Model 36801 Right-Angle Launcher, the Model 36802 MMIC Attachment, and the Model 36803 Bias Probe. This section contains a general description of each accessory, procedures for mounting it on the UTF, and its individual operational requirements.

5-2 RIGHT-ANGLE LAUNCHER

a. General Information

The Model 36801 Right-Angle Launcher (RAL) is used to make multi-port connections as well as right-angle connections to the test substrates. There are two models of the RAL; the Model 36801V which has a V Connector, and the Model 36801K which has a K Connector. The RAL comes equipped with an adjustment plate and a mounting base assembly. A typical RAL/UTF setup is shown in Figure 5-1.

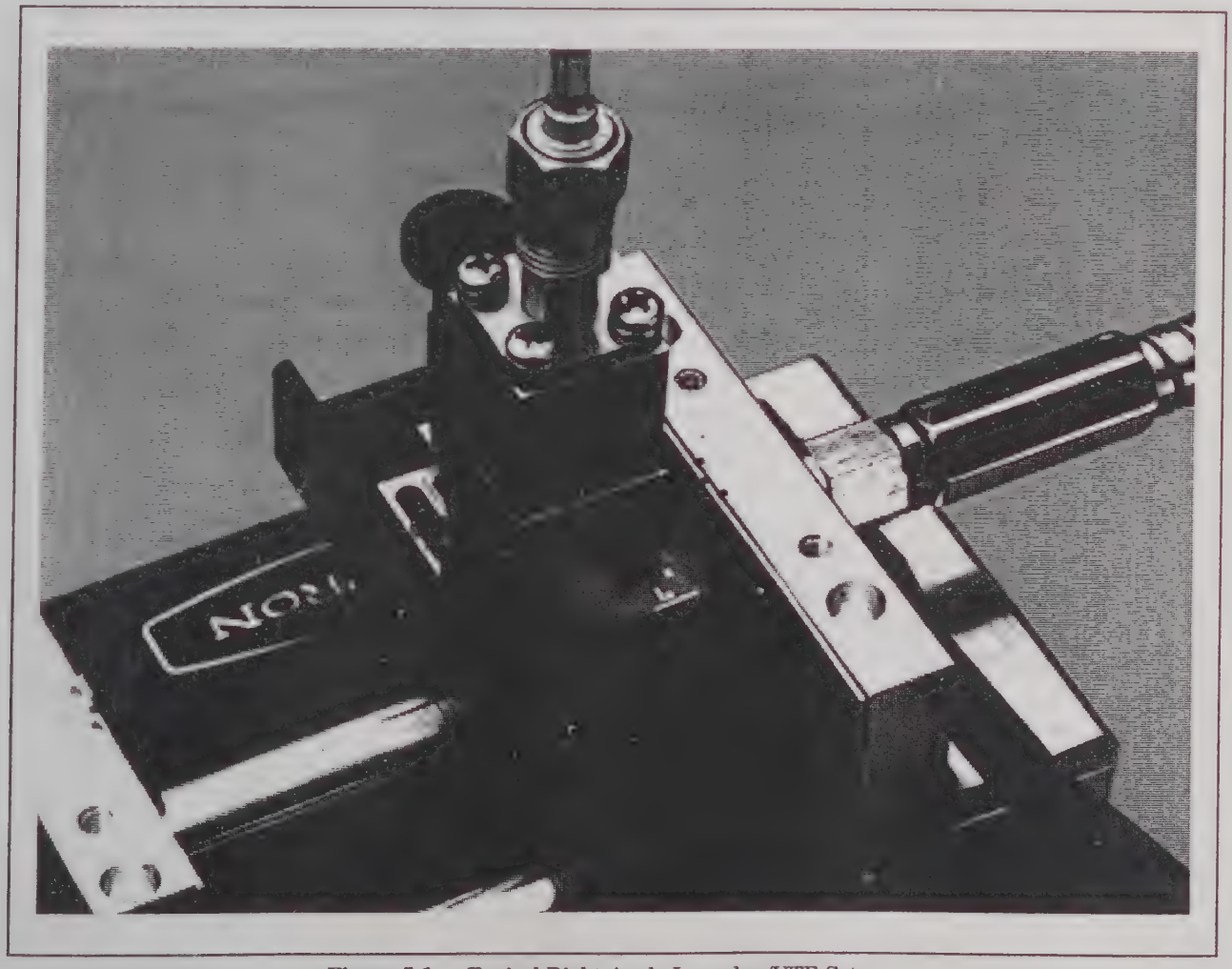


Figure 5-1. Typical Right-Angle Launcher/UTF Setup

Calibration of a VNA with an RAL/UTF setup is performed using the standard UTF calibration kit and following the calibration procedures found in Section 3. The RAL is mounted in line with the other connectors for calibration. After calibration, the RAL is moved to the position appropriate to the test substrate connection requirements. For multi-port measurements, separate calibrations must be done between each set of ports.

b. Mounting

1. Mount the RAL to the mounting base assembly with the two screws.
2. Connect the mounting base assembly to the slide rods of the UTF. For calibration, use the two outer mounting screws to fasten the mounting base assembly to the UTF. After calibration, the center mounting screw may be more convenient to use.
3. For calibration, mount the RAL in line with and facing the sliding connector block of the UTF. Position the RAL as close to the fixed connector block as possible.

NOTE

The connector of the RAL is mounted vertically, allowing the unit to be moved without bending the connection cable. As shown in Figure 5-1, it is recommended that a separate RF cable be used for the RAL connection.

c. Calibration

1. Mount and connect the RAL inline with and facing the sliding connector as described in paragraph 5-2b above.
2. Calibrate the VNA with the UTF in the normal manner following the calibration procedures in Section 3. Store the calibration data.

d. Measurement Setup

1. After calibration, loosen or remove the RF cable from the RAL.
2. Move the RAL to the appropriate location on the UTF, leaving the mounting screws for both the mounting base assembly and the RAL slightly loose.
3. Mount the substrate to be tested into the jaws of the sliding connector block and if appropriate, the fixed connector block.
4. Carefully adjust the position of the RAL so that the desired trace on the substrate is directly below the RAL center pin and is contacting the dielectric spacer rods.
5. Tighten the mounting screws.
6. Connect the RF cable, recall the appropriate calibration data, and make the test substrate measurements.

e. Upper Jaw Adjustment (If Required)

1. Clamp the 1 inch square adjustment plate supplied with the RAL into the UTF jaws.
2. Adjust the set screw in the lever of the RAL so that it opens the lower jaw. This prevents damage to the connector pin.
3. Loosen the RAL upper jaw screws.
4. Position the RAL so that the adjustment plate is under the upper jaw.
5. While applying slight pressure to the upper jaw, tighten the upper jaw screws firmly. Do ***not*** over torque.
6. Readjust the set screw in the lever of the RAL so that the lower jaw closes fully.
7. Inspect for the correct connector pin-to-substrate contact as described in Section 4 – Maintenance, paragraph 4-3b.2.(h).

f. Multi-Port Measurements

A separate calibration is required for each pair of test ports. Insure that the proper calibrations are stored on the disk so that they can be recalled when needed. Mount the substrate to be tested into the UTF and recall the desired calibration. It is important to remember that unused ports are not calibrated and therefore are not well terminated. If well-matched loads are required, it is recommended that the port be padded with a 6 dB or 10 dB attenuator.

5-3 MMIC ATTACHMENT

a. General Information

The Model 36802 MMIC Attachment is used to support testing of small substrates or substrates where it is not feasible to make connections with the UTF jaws. The MMIC attachment consists of two cam driven connection pin assemblies and a mounting base assembly. A connection substrate kit, which must be ordered separately, contains four connection substrates, a carrier mounting block, two shorts, and a spare pin foot. There are three models of the connection substrate kit; Model 36805-10M which supports testing of 10 mil substrates, Model 36805-15M which supports testing of 15 mil substrates, and Model 36805-25M which supports testing of 25 mil substrates.

Each connection substrate has a tab projecting from one end. The tab makes connection with the test substrate. The opposite end of the connection substrate is clamped into the UTF connector block jaws. The toe of each cam driven connection pin assembly is placed so that it is at the end of the connection substrate. When the cam is actuated, the pin presses the connection substrate down onto the carrier mounting block. Ground connection is made between the bottom side of the connection substrate and the carrier mounting block. The tab, which is slightly bent, makes connection with the test substrate. The illustration in Figure 5-2 shows the MMIC attachment/UTF setup.

The carrier mounting block can be used as a heat sink or with an optional hot/cold plate for thermal testing.

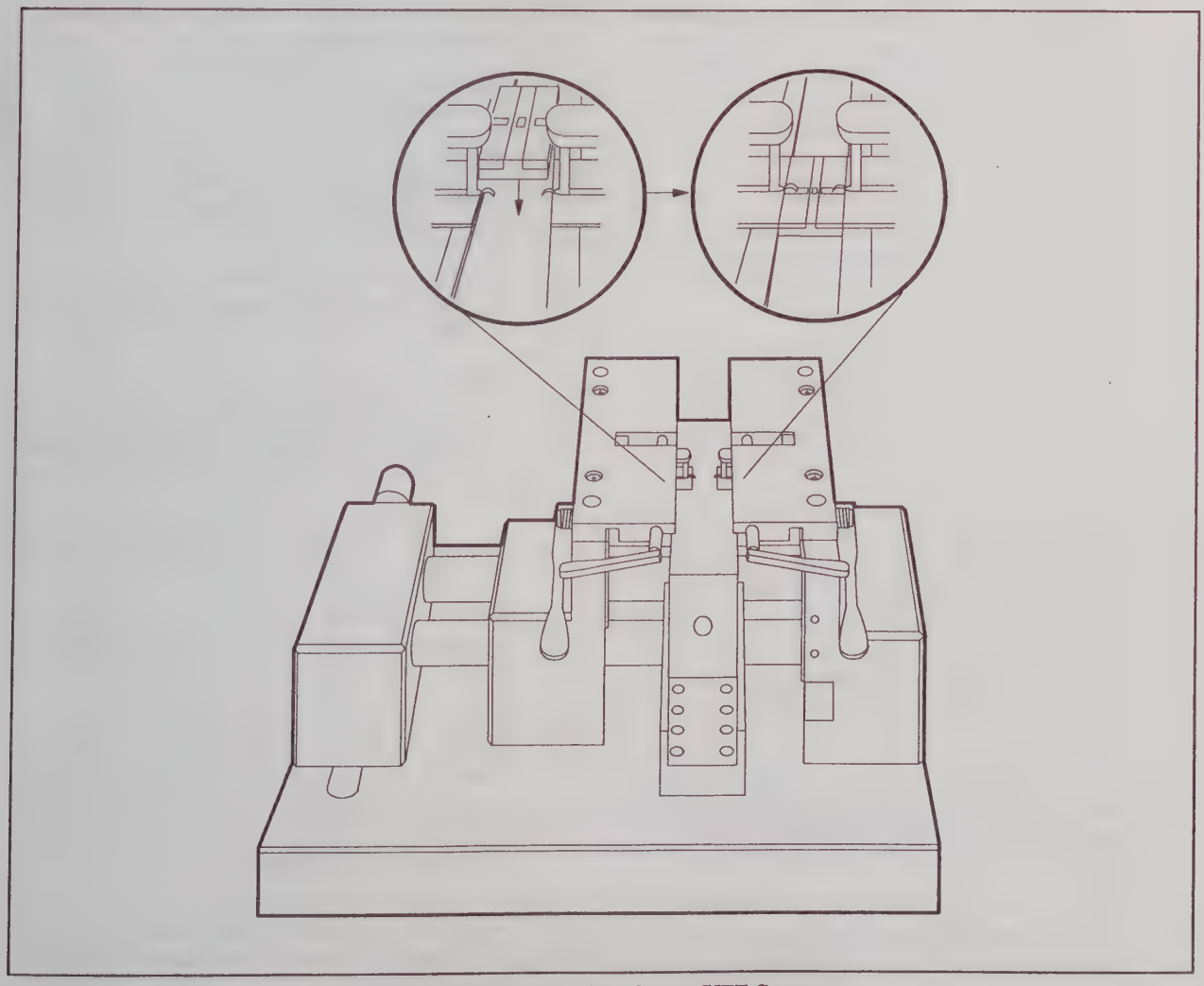


Figure 5-2. MMIC Attachment/UTF Setup

Calibration of the VNA with the MMIC attachment/UTF setup consists of an LRL calibration using the standard UTF calibration kit and the Section 3 calibration procedures. High frequency calibrations, ≥4 GHz, are performed on the carrier mounting block and include the effects of the tab-to-substrate bond. Low frequency calibrations, <4 GHz, are done before mounting the MMIC attachment to the UTF.

CAUTION

Use care when handling the connection substrates to avoid damaging the tabs.

b. Mounting

To mount the MMIC attachment to the UTF, proceed as follows:

1. Attach the MMIC mounting base assembly to the UTF slide rods using the center screw. (The MMIC carrier mounting block is held by the mounting base assembly.) Tighten the screw just enough to allow the unit to slide; rotating the retangular block slightly with a finger will loosen and tighten the base.
2. Mount the connection substrates into the jaws of the fixed and sliding connector blocks of the UTF. Insure that they are correctly positioned and firmly pressed against the dielectric spacer rods.
3. Move the UTF's sliding connector block to position the substrate tabs close to each other but not touching. Insure that the tabs are in line. If they are not in line, adjust the offset block of the UTF until they are in line.
4. Slide a carrier mounting block into the mounting base assembly. The top of the block should be approximately 5 to 9 mils below the bottom of the connection substrates. This gap can be enlarged by holding the connection substrate slightly above its natural position while clamping it into the UTF jaws. The gap can be narrowed by placing tape on the bottom of the carrier block.
5. Slide the MMIC mounting base assembly so that the connection substrate locked into the jaws of the fixed connector block overlaps the carrier block by approximately 0.030 inch.
6. Set a test substrate onto the carrier block and slide it under the tab of the connection substrate locked into the jaws of the fixed connector block. *Use care to avoid damaging the tab.* The test substrate height may need to be readjusted.
7. Move the sliding connector block until the test substrate is almost clamped between the two connection substrates. This will help to protect the tabs while the cam assemblies are being installed.
8. Install the cam assemblies, insuring that the cams are set so that the pins are in the upper most position (lever up). *Use care to avoid damaging the connection substrate tabs.*
9. Adjust each cam assembly so that the toe of the pin is directly centered over the tab and just touches the end of the connection substrate. Tighten the screws holding the cam assemblies.
10. Inspect the MMIC attachment/UTF setup to insure the following:
    (a) The connection substrate tabs are in line over the test substrate.
    (b) The cam assembly pins are properly placed over the tabs and the toe of each pin does not extend past the connection substrate.
    (c) The connection substrate ends are parallel so that the test substrate is held properly.

c. Calibration

Only high frequency (≥4 GHz) LRL calibrations are performed with the MMIC attachment mounted on the UTF. To perform this LRL calibration, proceed as follows:

1. Start a normal LRL calibration sequence (see paragraph 3-3.2).
2. On the UTF, pull the sliding connector block back so that it is off of the MMIC mounting base block.
3. Place the 1.00 cm LRL line substrate onto the MMIC mounting base block and carefully slide it under the tab of the connection substrate that is locked into the jaws of the fixed connector block. Insure that the center conductor is under the tab.
4. Move the sliding connector block so that the connection substrate gently touches the LRL line substrate. Insure that the tab is directly over the center conductor. It is OK for the

connection substrate to overlap the base block; it does not have to be near the edge.

5. Rotate the cam levers to allow the cam assembly pins to press the substrates together. The LRL substrates should be held down firmly during calibration to insure a good ground. The Model 36803 Bias Probe can be used for this purpose. Do ***not*** place the probe on the center strip of the calibration substrate.

6. Make the measurement and follow the sequence called for in the calibration.

d. Measurement

Replace the calibration substrate with the test substrate. The test substrate may be held in place by the connection substrate tab, which may not give a stable ground, or firmly attached to the MMIC carrier mounting block. If the substrate is firmly attached, insure that it is properly aligned before attachment.

If the test substrate is a different thickness than the connection substrate, the carrier mounting block or the carrier must be modified so that the top of the test substrate is the same height as the top of the connection substrate ±0.001 in. (±0.025 mm). Figure 5-3 provides examples of these modifications.

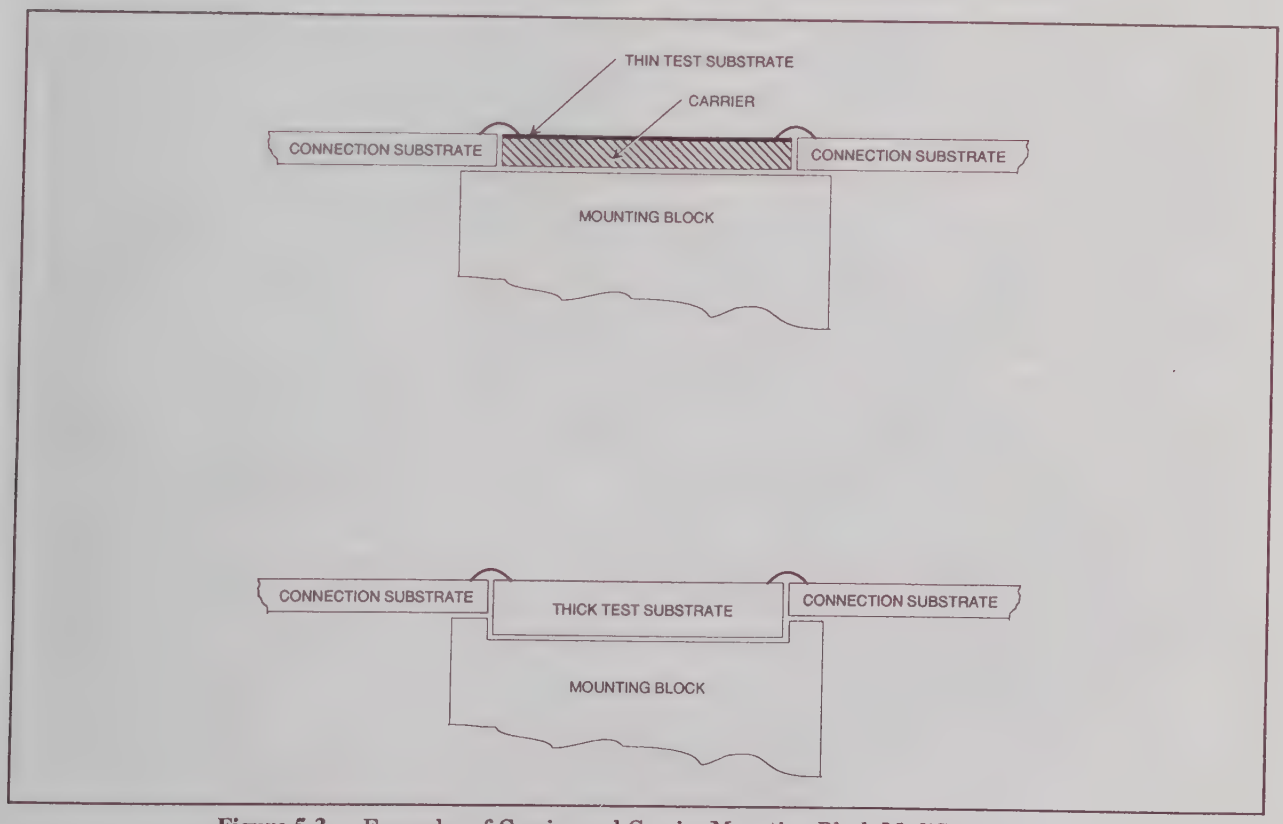


Figure 5-3. Examples of Carrier and Carrier Mounting Block Modifications

5-4 BIAS PROBE

The Model 36803 Bias Probe can be used either as a bias probe or as a hold-down for components. When used as a hold-down, the dielectric probe is used.

Bias probes plug into the large holes in the UTF connector blocks or the MMIC attachment. They are spring loaded to provide downward pressure. Set screws are provided to keep the bias probes from rotating once they are installed in the connector block. The length of the contact pin is adjusted with a set screw in the end of the rod. The location of the rod is adjusted by rotating the assembly or sliding the rod. The spring pressure is adjusted at the factory, but may be readjusted by moving the set screw in the top of the holding block.The UTF fixed connector block has a hole to mount the ground return cable. A typical Bias Probe/UTF setup is shown in Figure 5-4.

a. Using the probe assembly as a bias probe

1. Plug the probe assembly into an appropriate hole in a UTF connector block or MMIC attachment.
2. Lift the contact pin by pressing down on the back of the rod or lifting the front.
3. Slide and rotate the rod until the contact pin is over the bias pad and allow the pin to contact the pad.

b. Using the probe assembly as a hold-down for components

1. Replace the metal probe with the dielectric probe.
2. Adjust the spring tension as desired. *Do not over tighten the set screw.*

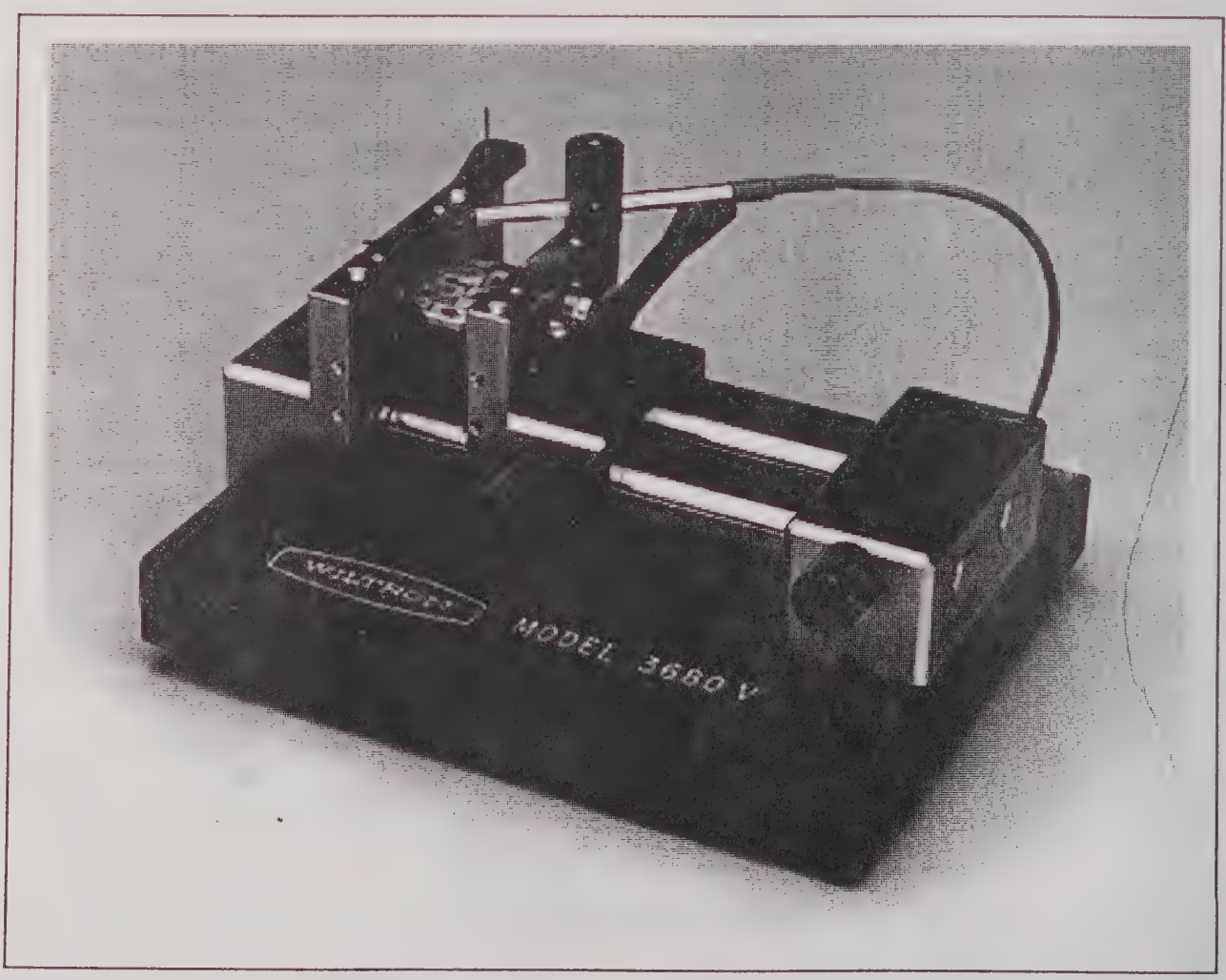


Figure 5-4. Typical Bias Probe/UTF Setup

SECTION VI
APPLICATIONS

6-1 INTRODUCTION

This section provides additional information on subjects related to the UTF. Information is provided concerning:

- UTF-to-microstrip connection pin design.
- Upper jaw modification.
- Making LRL calibration lines.
- Measurement considerations for soft substrate, substrate on a carrier, and substrate of different thickness than the calibration substrate.
- Substrate moding.

6-2 UTF-TO-MICROSTRIP CONNECTION PIN DESIGN

The center conductor pin on the back side of the UTF's RF connector (a K Connector or a V Connector) makes spring-loaded pressure contact with the microstrip. The center conductor pins of the K Connector and the V Connector differ in design. As illustrated in Figure 6-1, the main design difference between the two is that the pin of the K Connector contacts the substrate about 4 mils (0.1 mm) in from the edge of the substrate, while the pin of the V Connector must make contact at the edge of the substrate. The reason for this is that some design criteria demands that the microstrip trace end before the edge of the substrate. In such cases, a straight pin may not make contact with such a trace. At 60 GHz; however, not making contact at the edge results in poor RF performance.

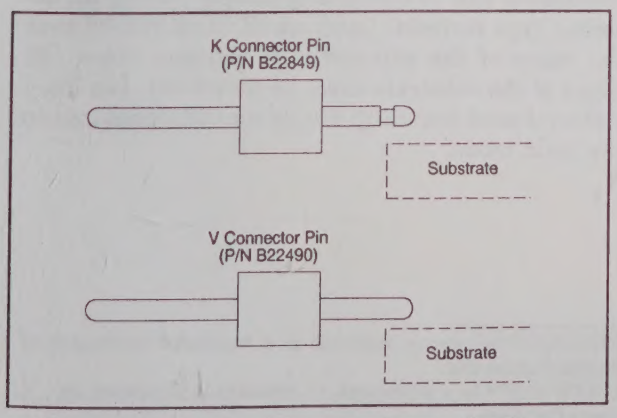


Figure 6-1. UTF-to-Microstrip Connection Pins

6-3 UPPER JAW MODIFICATION

The connector block upper jaw of the UTF can be modified to allow correct connection pin-to-substrate contact when the substrate is mounted in a channel on a carrier. Behind the upper jaw on the connector block are alternate mounting holes. The location of these alternate mounting holes in relation to the standard upper jaw mounting holes are shown in Figure 6-2 and are identified by the dashed circles labeled ALT. The alternate holes can be used if the standard screw location is in the way of proper connection. An example of upper jaw modification is shown in the lower half of Figure 6-2. A kit of upper jaws is available. Order Anritsu P/N C23845.

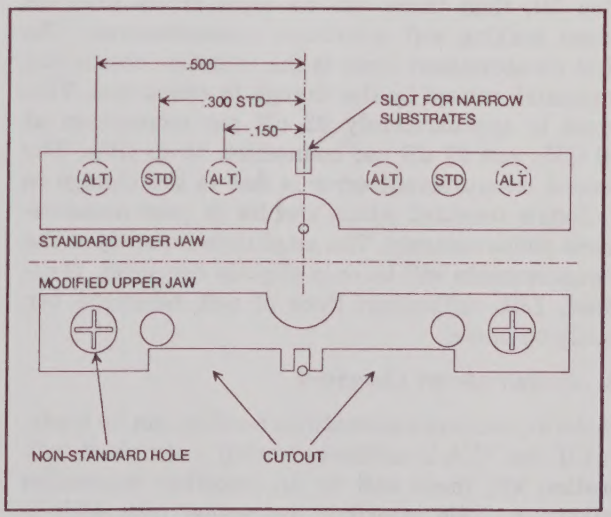


Figure 6-2. UTF Upper Jaws, Standard and Modified

6-4 MAKING LRL CALIBRATION LINES

LRL calibration lines can be easily made from microstrip using the following steps. Although it is not critical that the characteristic impedance of the LRL lines be exactly 50 ohms, for correct dispersion compensation the impedance should be within the range of 45 to 55 ohms.

1. Decide on frequency span. The maximum span is 9:1.
2. Select length of line one. 1 cm is a good choice.
3. Calculate the length of line 2. This length is 1/4 wavelength longer than line 1 at the center frequency. The center frequency is (F1 + F2)/2. Be sure to take the dielectric constant into account.
4. Make lengths of your transmission line.

NOTE

If the substrate used has a low dielectric constant, there could be some moding. Refer to paragraph 6-6 for more on substrate moding.

6-5 MEASUREMENT CONSIDERATIONS

a. Soft Substrate

When making measurements of soft substrate, the substrate lines should be at least 1 cm wide to prevent the soft material from being crushed by the pressure of the UTF jaws.

If the VNA is calibrated using an alumina calibration kit, then there will be some errors involved when making soft substrate measurements. The first measurement error is the interface connection mismatch caused by the change in substrates. This error is approximately 33 dB per connection at 20 GHz and 27 dB per connection at 40 GHz. The second measurement error is due to the change in dielectric constant which results in poor measurement phase accuracy. The amplitude accuracy of the measurements will be only slightly degraded. If desired, LRL calibration lines of soft substrate can easily be made.

b. Substrate on Carriers

Measurements of substrate on carriers can be made, but if the VNA is calibrated using a standard calibration kit, there will be an interface connection mismatch. This interface connection mismatch is proportional to the thickness of the carrier and is caused by the inductive effect of the longer ground path. The mismatch error from a 30 mil carrier at 20 GHz is approximately 30 dB per connection. Very thick carriers are not recommended, especially at frequencies above 20 GHz. If desired, LRL calibration lines of substrate on carrier can be made.

It is extremely important that the carriers be flat. If they have a concave bow, the ground connection will not be made directly under the connector pin and poor measurement results can be expected.

On some carriers, the substrate sits in a channel, with the top of the carrier extending above the top of the substrate. In this case, the upper jaw of the UTF will prevent the substrate from making contact with the connection pin. The upper jaw can be modified to allow correct connection pin-to-substrate contact (paragraph 6-3).

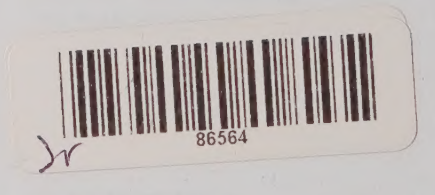
c. Substrate of Different Thickness Than the Calibration Substrate

When making measurements of test substrate that is of a different thickness than the calibration substrate, there are two measurement errors involved. These measurement errors are (1) an interface connection mismatch error and (2) a phase accuracy error due to the different dispersion characteristics of the substrates. The interface connection mismatch error will be proportional to the difference between the substrates. For example, if the calibration substrate is 10 mil alumina and the test substrate is 15 mil alumina, the interface error at 20 GHz is approximately 32 dB at each connection. Paragraph 6-5a provides more information on interface connection mismatches.

6-6 SUBSTRATE MODING

On the UTF, substrate ground is made only at the connection ends of the substrate. This does not pose a problem in most cases, especially if the substrate has a high dielectric constant. But if the substrate has a low dielectric constant, such as RT/duriod ® or Quartz, there may be some moding or glitches at various frequencies. This is due to secondary modes which can reach the edge boundaries and become resonant. The resonant frequencies are proportional to the width of the substrate. In most cases, these resonances can be damped by simply placing an absorber type material (such as ECCOSORB ™) near the edges of the substrate. In extreme cases, the edges of the substrate must be metalized. The lossy material used normally causes no additional loss to the main mode.

RT/duriod ® microwave laminate is a registered trademark of Rogers Corporation.
ECCOSORB ™ is a trademark of Emerson & Cumming Inc., A Grace Company.



Anritsu

Anritsu Company • 490 Jarvis Drive • Morgan Hill, CA 95037-2809
FAX (408) 778-0239

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